Physics 211 Test 4A

Section 1: Dr. Gladden, Oct. 27, 2010

NAME: KEY UM ID#: ____________________

Conceptual Multiple Choice (*2 points each*): Clearly write the letter corresponding to the BEST possible answer in the space provided. You may also circle the answer to be sure.

1. B Pressure is
   A) proportional to both force and area.
   B) proportional to force and inversely proportional to area.
   C) inversely proportional to force and proportional to area.
   D) inversely proportional to both force and area.

2. B 50 cm^3 of wood is floating on water, and 50 cm^3 of iron is totally submerged. Which has the greater buoyant force on it?
   A) the wood
   B) the iron
   C) Both have the same buoyant force.
   D) cannot be determined without knowing their densities

3. B As a rock sinks deeper and deeper into water of constant density, what happens to the buoyant force on it?
   A) It increases.
   B) It remains constant.
   C) It decreases.
   D) It may increase or decrease, depending on the shape of the rock.

4. A Water flows through a pipe. The diameter of the pipe at point B is larger than at point A. Where is the speed of the water greater?
   A) point A
   B) point B
   C) same at both A and B
   D) cannot be determined from the information given

5. B You double your distance from a sound source that is radiating equally in all directions. What happens to the intensity of the sound? It reduces to
   A) one-half its original value.
   B) one-fourth its original value.
   C) one-sixteenth its original value.
   D) none of the above

6. D An ideal fluid flows at 12 m/s in a horizontal pipe. If the pipe widens to twice its original radius, what is the flow speed in the wider section?
A) 12 m/s
B) 6.0 m/s
C) 4.0 m/s
D) 3.0 m/s

7. B Which one of the following is associated with the law of conservation of energy in fluids?
A) Archimedes' principle
B) Bernoulli's principle
C) Pascal's principle
D) equation of continuity

8. C For a periodic process, the number of cycles per unit time is called the
A) amplitude.
B) wavelength.
C) frequency.
D) period.

9. A For vibrational motion, the maximum displacement from the equilibrium point is called the
A) amplitude.
B) wavelength.
C) frequency.
D) period.

10. A A mass on a spring undergoes SHM. When the mass passes through the equilibrium position, its instantaneous velocity
A) is maximum.
B) is less than maximum, but not zero.
C) is zero.
D) cannot be determined from the information given.

11. B A mass is attached to a vertical spring and bobs up and down between points A and B. Where is the mass located when its potential energy is a minimum?
A) at either A or B
B) midway between A and B
C) one-fourth of the way between A and B
D) none of the above

12. C Doubling only the amplitude of a vibrating mass-and-spring system produces what effect on the system's mechanical energy?

A) increases the energy by a factor of two

B) increases the energy by a factor of three

C) increases the energy by a factor of four

D) produces no change

13. B Increasing the mass M of a mass-and-spring system causes what kind of change in the resonant (or natural) frequency of the system? (Assume no change in the system's spring constant k.)

A) The frequency increases.

B) The frequency decreases.

C) There is no change in the frequency.

D) The frequency increases if the ratio k/m is greater than or equal to 1 and decreases if the ratio k/m is less than 1.

14. C Simple pendulum A swings back and forth at twice the frequency of simple pendulum B. Which statement is correct?

A) Pendulum B is twice as long as A.

B) Pendulum B is twice as massive as A.

C) The length of B is four times the length of A.

D) The mass of B is four times the mass of A.

15. C The distance between successive crests on a wave is called the wave's

A) speed.

B) frequency.

C) wavelength.

D) amplitude.

16. A For a wave, the frequency times the wavelength is the wave's

A) speed.

B) amplitude.

C) intensity.

D) power.

17. A The intensity of a wave is
A) proportional to both the amplitude squared and the frequency squared
B) proportional to the amplitude squared and inversely proportional to the frequency squared.
C) inversely proportional to the amplitude squared and proportional to the frequency squared.
D) inversely proportional to both the amplitude squared and the frequency squared.

18. B Sound vibrations with frequencies greater than 20,000 Hz are called
A) infrasonics.
B) ultrasonics.
C) supersonics.
D) none of the above

19. B Which of the following is a false statement?
A) Sound waves are longitudinal pressure waves.
B) Sound can travel through a vacuum.
C) Light travels very much faster than sound.
D) The transverse waves on a vibrating string are different from sound waves.
E) "Pitch" (in music) and frequency have approximately the same meaning.

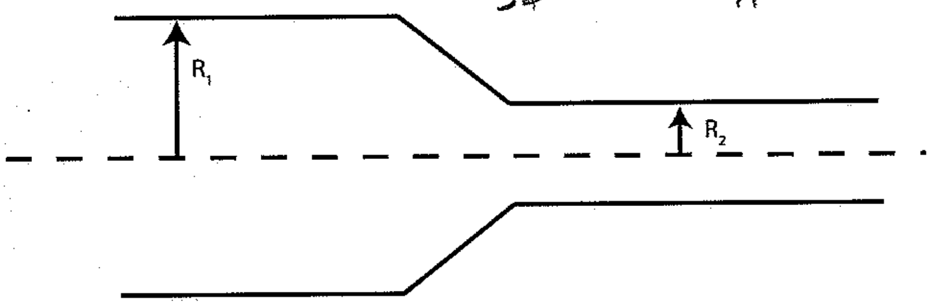
20. C Pressure and displacement waves are
A) in phase.
B) 45° out of phase.
C) 90° out of phase.
D) 180° out of phase.

Test B

1. C
2. C
3. B
4. C
5. B
6. D
7. B
8. C
9. A
10. A
11. B
12. C
13. B
14. B
15. B
16. A
17. A
18. B
19. B
20. A

2. (*20 points*) The figure shows a pipe with a circular cross section which constricts from a radius of 0.20 m to 0.050 m. The velocity of the flow in the large section is 3.0 m/s.

$\rho_f = 1000 \frac{kg}{m^3}$



(a) What is the volume flow rate in the large section?

Volume flow rate is

$$A v = \pi R_1^2 (3.0 \, m/s)$$
$$= 0.377 \frac{m^3}{sec}$$

(b) What is the speed of the flow in the small section?

By Continuity Equ.

$$A_1 v_1 = A_2 v_2$$

so $v_2 = \frac{A_1}{A_2} v_2 = \frac{\pi R_1^2}{\pi R_2^2} v_2 = 48 \, m/s$

(c) If the pressure is the large section is ~~125,000~~ 2.0×10^6 Pa, what will the pressure be in the small section?

By Bernoulli eqn (with $h_1 = h_2$)

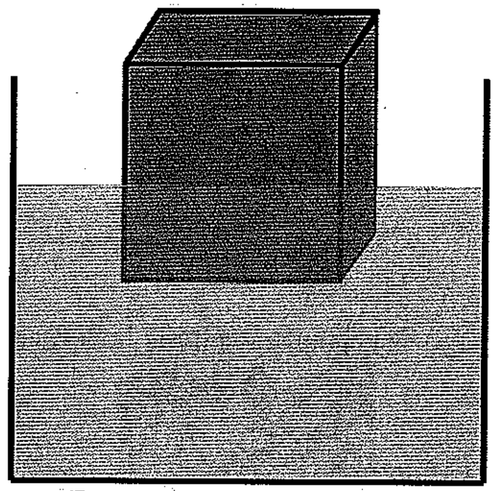
$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2)$$
$$= 125{,}000 \text{ Pa} + \frac{1}{2}(1000 \tfrac{kg}{m^3})(3^2 - 48^2) = \boxed{1.1 \times 10^6 \text{ Pa}}$$

Problems: Work each of the following problems. Make sure to **show your work** and put a box around your final answer.

$(700 \frac{kg}{m^3})$

1. (*20 points*) A cube of wood with density 0.7 g/cm^3 and sides 4.0 cm is placed in a bucket of water (ρ=1.0 g/cm^3).



(a) What is the weight of the wood?

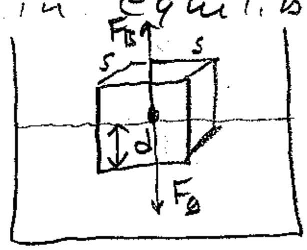
$$F_g = Mg = \rho_s V g$$
$$= \rho_s s^3 g$$
$$= 700 \frac{kg}{m^3} (0.04 m)^3 \, 9.8 \, m/s^2$$
$$= 0.44 \, N \text{ down}$$

(b) If the cube where completely submerged, what would the buoyant force be?

$$F_B = \rho_F (V) g$$
$$= 1000 \frac{kg}{m^3} (0.04 m)^3 \, 9.8 \, m/s^2$$
$$= 0.627 \, N \quad \text{up}$$

(c) When placed in the water, how deep will the cube sink until it stops sinking (that is when equilibrium is reached)?

When $|F_B| = |F_g|$ then it is in equilibrium



$$\rho_f (s^2 d) g = \rho_s s^3 g$$

so $$d = \frac{\rho_s}{\rho_f} s = \frac{700}{1000} 0.04 m = 0.028 m$$

$$\boxed{d = 2.8 \, cm}$$

Extra Credit (5 points)
In Problem 1, when the floating block is displaced from equilibrium by an amount y, what will the restoring force be as a function of y? If it were pushed down and released, what type of motion would it have?

(let x displacement from equilibrium)

$$\Sigma F = F_B - F_g$$

$$= \rho_f s^2 (d-x) g - \rho_s s^3 g \quad , \quad d = \frac{\rho_s}{\rho_f} s$$

$$= \rho_f s^2 \frac{\rho_s}{\rho_f} s g - \rho_f s^2 x g - \rho_s s^3 g$$

$$= s^3 \rho_s g - s^2 \rho_f x g - \rho_s s^3 g$$

$$= -s^2 \rho_f g x$$

by Newton's 2nd

$$\Sigma F = Ma = -s^2 \rho_f g x$$

Since $F \propto -x$ → this is Simple harmonic Motion!

This wasn't required, but kind of cool!

Natural freq

$$\omega = \sqrt{\frac{s^2 \rho_f g}{M}} \quad , \quad M = \rho_s s^3$$

$$= \sqrt{\frac{s^2 \rho_f g}{s^3 \rho_s}} = \sqrt{\frac{\rho_f g}{s \rho_s}}$$

3. (*20 points*) A 0.25 kg mass is connected to a spring with spring constant k=125 N/m and slides on a frictionless surface. It is initially displaced from equilibrium by 0.15 m and is released.

(a) What is the total mechanical energy in the system?

$$E_{tot} = \frac{1}{2} k A^2 = \frac{1}{2}\left(125 \frac{N}{m}\right)(0.15 m)^2$$

$$= 1.41 J$$

(b) What will the speed be through the equilibrium position?

$$E_{tot} = \frac{1}{2} k A^2 = \frac{1}{2} m v_{max}^2 \quad \text{by Conservation of energy}$$

$$\text{so } v_{max} = \sqrt{\frac{k}{m}}\, A = \sqrt{\frac{125}{0.25}}\,(0.15 m)$$

$$= 3.35 \text{ m/s}$$

(c) If time starts when the mass is released, sketch a graph of the position as a function of time below. Clearly mark on the time axis at what time the mass returns to the starting position (I need a number here). Also mark on the displacement axis, the amplitude (also need a number here).

$$T = 2\pi \sqrt{\frac{m}{k}} = 0.28 s$$